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Monarch Butterfly Conservation Through the Social Lens: Eliciting Public Preferences for Management Strategies Across Transboundary Nations

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The monarch butterfly *(Danaus plexippus)*, an iconic species that migrates annually across North America, has steeply declined in numbers over the past decade. Across the species' range, public, private, and non-profit organizations aim to reverse the monarch decline by engaging in conservation activities such as habitat restoration, larvae monitoring, and butterfly tagging. Urban residents can actively participate in these activities, yet their contribution can also be realized as an electorate body able to influence the design of conservation programs according to their interests. Little is known, however about their preferences toward the objectives and design of international monarch conservation policies. In this paper, we investigate these preferences via a survey design using Discrete Choice Experiments (DCEs) and Latent Class Analysis (LC) of urban residents across the main eastern migratory flyway in Ontario, Canada, and the eastern United States. Attributes in the DCE included the size and trend of overwintering butterfly colonies, the type of institution leading the conservation program, international allocation of funds, and the percentage of funds dedicated to research. From the general populace, we isolated respondents already engaged in monarch conservation activities to explore how they compare. We sent a smaller set of surveys deliberately withholding the expected-success forecast of the monarch recovery program to assess the value of information for urban residents within a conservation context. The LC distinguished three groups of respondents among urban residents: (1) the main group, labeled "Eager," accounting for 72.4% of the sample, that showed a high potential for supporting conservation policies and had remarkable similarities with the monarch enthusiasts' sample; (2) a "Pro Nation" group (18.4%) marked by their increased willingness to support conservation initiatives solely focused within their country of residence; and (3) an "Opinionated" segment (9.23%), that was highly reactive to changes of the leading institution, resources allocation, and economic contribution proposed. Key findings from

this research reveal that to maximize potential support amongst urban residents in the monarch's breeding range, a conservation strategy for the monarch butterfly should be led by not-for-profit organizations, should strive for transboundary cooperation, and should include the communication of anticipated ecological outcomes.

Keywords: monarch butterfly, citizen science, choice experiment, latent class, conservation, public preferences, international cooperation, transboundary conservation

INTRODUCTION

The design of conservation strategies for transboundary migratory species has proven to be a challenging topic for decision makers, partly due to the presence of multiple institutions, groups of interest, administrative barriers, and political and cultural differences (Grant and Quinn, 2007). The monarch butterfly (*Danaus plexippus*; henceforth referred to as "monarch") is a highly migratory and globally distributed butterfly species (Oberhauser et al., 2008). Its eastern North American population has the longest migration (Brower and Missrie, 1999)—up to 4,000 km—in which butterflies across the eastern states/provinces of the US and Canada establish overwintering colonies within a few specific forest patches in Mexico (Urquhart and Urquhart, 1976). The area occupied by monarchs in these overwintering sites has decreased from an average area of 5.71 ha in 1993 to an all-time-low area of 0.67 ha during the 2013–2014 season (Vidal and Rendón-Salinas, 2014). Its current estimate is at 6.05 ha (Rendón-Salinas et al., 2019).

Habitat destruction in both overwintering and breeding areas is currently the most plausible hypothesis for the population decline (Brower et al., 2012). Overwintering monarch colonies rely on the forest canopy for protection against freezing temperatures, precipitation, and wind (Anderson and Brower, 1996). During the breeding season, monarchs depend on milkweed (*Asclepias* spp) for larvae feeding across the breeding range from Northern Mexico to the northeastern US and eastern Canadian provinces (Zalucki et al., 2001). Here, agricultural land transformation combined with the introduction of transgenic-specific herbicides for crop management, to which only genetically modified crops can resist, have caused a general decline in milkweed abundance across the eastern states of the US over the last decade (Pleasants and Oberhauser, 2012).

In addition to those multiple stressors, the heterogeneous sociopolitical backdrop of the monarch's decline is a considerable challenge as well. Different resource-extraction activities, socioeconomic differences (Lopez-Hoffmann et al., 2009), and distinct legislative tools and processes for its protection (Waples et al., 2013) can hinder the effectiveness and coherence of joint strategies (Scott and Collins, 1997). Moreover, the limited resources available for conservation, from governments and NGOs alike, are allocated based on national priorities, which may significantly differ between countries. For example, while the monarch butterfly is a top priority for WWF-Mexico with more than 25 scientific monarch-related reports (WWF- Mexico, 2018), its Canadian office 2017 annual report has no mention of the monarch butterfly (Miller, 2017). Additionally, since political institutions tend to be responsible for internalizing environmental externalities, with their mandates focusing on local issues, externalities at an international level are frequently overlooked (Perrings and Halkos, 2012). One example of such an externality is the potential loss of revenue that Mexican communities incur from monarch-reserve tourism caused by extensive use of herbicides in the North (Esquivel-Rios et al., 2014).

Despite this intricate sociopolitical backdrop, the monarch's decline and its widespread appeal have spurred people's interest in its protection across the migratory flyway. For example, The Monarch Waystation program, an initiative seeking to stimulate the public to provide habitat for monarchs and other pollinators, is continually increasing its presence every year, with 21,946 registered waystations up to date (Lovett, 2018). Likewise, Journey North, an entry-level citizen science platform, received 1,574 reports of egg sightings and 14,381 adult sightings during fall 2017, contrasted with 193 eggs and 3,310 adults reported in 2012. Several other citizen science hubs have witnessed that same surge of interest by the general public such as the Monarch Watch Tagging Program, eButterfly, iNaturalist, and the Monarch Larvae Monitoring Program. Such participation of private residents in citizen science and ecologically-related activities provide scientists with an extraordinary capacity of having useful, cost-effective data collected and analyzed. Ries and Oberhauser (2015) estimated that 17% of 503 papers related to the monarch since 1940 have relied on citizen science data. Moreover, Lewandowski and Oberhauser (2017) found that individuals engaged in citizen science activities are more likely to provide and protect critical habitat as well.

However, the role of the general public in protecting the monarch, as well as any other imperiled species, can go beyond data gathering and habitat provision—at which farmers could be substantially more effective (Thogmartin et al., 2017). Instead, when a conservation target is embedded within a complex network of economic and cultural interests at a transboundary level as described above, the involvement of the general public is especially needed. Agnone (2007) studied how the general public's opinion and protests have impacted the passage of environmental laws in the United States between 1960 and 1998. Several national conservation policies have been successful when the public is engaged. For example, Lutrin and Settle (1975) documented the success of passing California's Coastal Zone Conservation Act due to the active engagement of the Coastal

Abbreviations: ASC, Alternative Specific Constant; DCE, Discrete Choice Experiment; LC, Latent Class or Latent Class Analysis; MNL, Multinomial Logit Model; NEP, New Environmental Paradigm Scale; RI, Relative Importance; WTP, Willingness to Pay; mWTP, Marginal Willingness to Pay.

Alliance with the public and contrasted it with the failure on passing the Clean Air Initiative that same year due, most likely to a lack of public engagement. More recently, Nicholls (2017) documented the crucial role the general public had for the introduction of neonicotinoid regulations in Ontario. We expect that, just as in the national context, at the transboundary level, finding the specific levers to promote the support of the general public for conservation policies could strongly influence the design, reach, and ultimately, success of conservation policies.

The present paper seeks to improve the understanding of public preferences for transboundary conservation strategies for the monarch butterfly conservation. Its main goal is to determine whether inherent heterogeneity exists in public preferences for strategic-level characteristics of a recovery-management strategy that includes institutional leadership, international cooperation, and support for citizen science and research activities. It also aims to evidence the effect that providing a projection of the conservation program's success has on the overall willingness of people to support such a program. We used Discrete Choice Experiments (DCE) with a Latent Class Analysis (LC) to achieve such objectives.

METHODS

Sampling

The sampling area included the 35 eastern-most states of the US and Canada (Ontario), representing all areas where there is more than a 50% probability that monarch populations are present (Galindo-Leal et al., unpublished). Geographically speaking, the US-Mexican Border, parallel 49, meridian 102, and the east coast constitute the southern, northern, western and eastern limits of the sampling area, respectively (**Figure 1**). Based on the study objectives, we surveyed three different respondent samples: (1) main urban residents, (2) sample of monarch enthusiasts, and (3) modified urban residents' sample with a modified version of the survey to investigate the value of knowledge.

The surveying tool was delivered through the Survey Sampling International marketing company (Teel and Manfredo, 2010), targeting urban residents[1] within the sampling area. Respondents were obtained from the panellists' database of the marketing company and were contacted directly by them based on our target demographics via email with an invitation link. The survey was sent in batches of 100, and only after analyzing their geographic and gender representativeness, the next batch of surveys was sent adjusting the target demographics to obtain a representative sample.

An invitation link was also sent through the Monarch Watch DPLEX mailing list[2], which contains subscribers, mostly citizen scientists, dedicated to the conservation of the monarch. This list is maintained by Monarch Watch, a non-profit organization hosted at the University of Kansas and dedicated to the monarch butterfly conservation (Lovett, 2018). We additionally isolated responses of individuals self-reported as engaged in monarch conservation activities from the main urban resident's sample and pooled their responses with the ones from the DPLEX mailing list to obtain a monarch enthusiasts' sample.

The use of an online survey through a marketing company, instead of a mailed or in-person survey, was due to the geographical and numeric extension of the sample. Online internet surveys have many other advantages, such as reduced cost and higher design flexibility. However, they also introduce new potential sources of bias that have to be accounted when analyzing the results such as a potential increase of self-selection processes (Olsen, 2009) and the risk of introducing "professional respondents" to the sample (Dennis, 2001).

The presence of "professional respondents" is one of the main risks associated with using marketing companies for delivering an online surveying tool. Such respondents tend to click through the survey without paying proper attention and potentially adding unwanted noise to the results (Dennis, 2001). To control for this, following Malhotra (2008), we removed individuals with a time-to-completion of two standard deviations away from the mean (individuals that averaged their responses in <5 s or above 22 min per question, including the choice experiment). This range was chosen since we could not find any evidence of primacy (Belson, 1966) or recency (Kalton et al., 1978) effects within those outliers. Most of the outliers did not complete the demographics section of the survey, for the few that did answer that section, we tested their demographics and attitudinal responses against the rest of the sample and did not find any significant differences (Malhotra, 2008). Lastly, an instructional manipulation check question was embedded (Oppenheimer et al., 2009) within the survey which read: *"This question is intended to filter respondents that are not reading every question thoroughly. Please select the option 'Very Little' as your answer. Another question like this one will be placed further in the survey."*

We sent out the survey to 5,750 people in Canada and the US from which we received 2,557 responses with an overall completion rate[3] of 40.13%. The main sample included 916 individuals from Canada and 943 from the US, from which 302 self-reported as being monarch enthusiasts. Twenty-nine additional surveys were obtained through the Monarch Watch mailing list. We pooled the monarch enthusiasts from those two samples into a Monarch enthusiasts' group of 331 respondents. Finally, we sent 1,104 surveys with a variation of the DCE obtaining 625 completed surveys for the modified urban resident's sample with a completion rate of 56.51%. Completion rates varied according to the source of the respondents (marketing company = 46.4%, Monarch watch = 66.26%), and their nationality (Canada = 38.49%, US = 49.4%). Although our sample was mostly similar to the demographics of the target population, there were some significant differences, e.g., respondents from the sample with no high school diploma were 30% whereas the target population was 52%. Such demographic differences may be an effect of the way we defined urban residents in comparison to how it is stated in the census data, also, being

[1]We defined as Urban Resident a person that does not derive their main source of income from agriculture and owns a non-rural postal code.

[2]The survey was sent as an open link; however, we did not observe any duplicate IP addresses in the responses.

[3]Here and elsewhere, completion rate is defined as the number of surveys filled out and submitted divided by the number of surveys started.

FIGURE 1 | Sampling area. The sampling area includes the 35 eastern-most states of the US and Canada (Ontario), representing all areas where there is more than a 50% probability that monarch populations are present for breeding purposes. Geographically speaking, the US-Mexican Border, parallel 49, meridian 102, and the east coast constitute the southern, northern, western, and eastern limits of the sampling area, respectively.

this the reason to not balance the sample with an iterative proportional fitting or other raking procedure (Kolenikov, 2014); nevertheless, broad generalities to the target population can still be inferred. Respondents' demographics from the main urban residents and monarch enthusiasts' samples are summarized in **Tables 1**, **2**, respectively.

Survey Overview

Choice-experiments data were collected using a web-based survey conducted during November 2016 across Canada (Ontario) and the eastern US. The survey consisted of the following sections: (1) assessment of the individual's knowledge about the monarch, (2) video introduction for the survey and essential terminology, (3) choice experiment, (4) follow-up questions, (5) demographics, and (6) New Environmental Paradigm Scale (NEP) Statements. The survey also included questions on the allocation of resources and level of involvement of different organizations, which were not analyzed here but will be revisited in subsequent manuscripts.

The survey design and delivery were developed following Salant and Dillman (1994) and Dillman et al. (2014) design principles. Before giving any information about the monarch, we elicited the individual's knowledge of the monarch through three Likert-scale questions: (1) awareness of the monarch's decline, (2) level of concern about the current monarch's situation, and (3) awareness of the importance of milkweed for the monarch's survival and conservation. A short introductory video (2:32 min) followed explaining the purpose of the survey, the current decline of the monarch's population, and the definition of each DCE attribute. We used a video instead of text to avoid cognitive fatigue and to ensure respondents had a better understanding of the survey elements (Mendelson et al., 2017). Although we were unable to confirm that all respondents watched the video, they were unable to skip forward through the video to continue with the survey before it ended. The full survey and the video can be found in the **Supplementary Material**.

A demographics section was included after the DCE and, finally, the respondent was presented with the NEP Scale for the assessment of their environmental attitudes (Dunlap, 2008). The NEP scale consists of 15 environmentally-related statements to which the respondent must choose their level of agreement/disagreement. The totalled result is a score between 0 and 150, where the higher the score, the more ecologically oriented the mindset of the respondent (Dunlap and Van Liere, 1978).

Discrete Choice Experiment (DCE)

The DCE is a stated preference valuation method that forces the respondent to make trade-offs between distinct levels and attributes ideally resembling the context in which individuals make real-life decisions. The DCE assumes that respondents' decisions follow the Random Utility Model, which states that an individual will strive to maximize utility while making choices (Manski, 1977). Under this assumption, it is possible to estimate the proportion of the sample, market share, that would choose any given program configuration (Landauer et al., 2012). By including a contribution attribute, the marginal economic value

TABLE 1 | Demographics from the main sample of urban residents (n = 1,859).

Demographic variable				
Gender	**Canada**		**US**	
	Obs.	Exp.	Obs.	Exp.
Female	26.3%	26.1%	27.8%	25.1%
Male	23.9%	24.6%	21.5%	24.2%
Other	0.5%	0.0%	0.1%	0.0%
Age	**Canada**		**US**	
	Obs.	Exp.	Obs.	Exp.
19	2.1%	0.8%	1.1%	0.9%
21–24	3.2%	4.1%	2.5%	4.5%
25–34	10.2%	8.5%	12.1%	8.7%
35–44	9.8%	8.3%	9.9%	8.2%
45–54	9.0%	9.2%	7.2%	9.0%
55–64	9.9%	9.0%	9.7%	8.5%
65 or more	6.5%	10.9%	6.8%	9.6%
Educational attainment	**Canada**		**US**	
	Obs.	Exp.	Obs.	Exp.
Elementary or middle school graduate (grades 1–8)	0.5%	6.4%	0.5%	3.4%
High school graduate (grades 9–12)	8.1%	11.8%	9.5%	16.0%
Some post-modified education	6.3%	2.5%	9.0%	12.1%
Bachelor's degree	15.4%	8.3%	12.5%	9.1%
College or trade certification	13.7%	16.9%	8.8%	3.4%
Graduate, post-doctoral or professional degree	6.8%	4.7%	8.8%	5.2%

Demographic variable				
Household size	**Canada**		**US**	
	Obs.	Exp.	Obs.	Exp.
1 Person	7.6%	14.0%	8.7%	14.1%
2 Persons	17.6%	17.3%	16.1%	15.9%
3 Persons	10.7%	7.9%	10.3%	7.9%
4 Persons	9.8%	7.3%	10.1%	6.5%
5 Persons	3.4%	2.8%	2.9%	3.0%
6 Persons	1.4%	0.5%	0.8%	1.1%
7 Persons	0.2%	0.5%	0.2%	0.4%
8 Persons	0.1%	0.5%	0.3%	0.4%
Level of income	**Canada**		**US**	
	Obs.	Exp.	Obs.	Exp.
<$24,999	4.0%	19.0%	8.5%	11.2%
$25,000–$34,999	2.7%	5.9%	5.3%	9.1%
$35,000–$49,999	5.0%	7.5%	6.3%	10.7%
$50,000–$74,999	7.6%	7.4%	9.8%	11.0%
$75,000–$99,999	9.1%	3.7%	8.4%	4.8%
$100,000–$149,999	10.9%	2.4%	6.4%	4.0%
$150,000–$199,999	3.1%	0.6%	1.6%	1.0%
$200,000 or more	1.7%	0.6%	0.9%	0.9%
No response	6.5%	0.0%	2.2%	0.0%
Region				
	Obs.	Exp.		
Central United States	39.6%	31.0%		
North US and Canada	35.6%	38.1%		
South United States	24.7%	30.9%		

"Obs" is the observed percentage from the sample and "Exp" is the expected percentage of people based on census data (Statistics Canada, 2016 Census of Population; https://www.census.gov/). The definition of urban resident of the US Census and Statistics Canada differed from ours. While their definition is based on population density, presence on urban clusters or urbanized areas, land use, distance, and population thresholds, our definition is based on main source of income and zip code. Note that some items do not add up to the total sample size due to missing data from incomplete responses.

of the attributes can be estimated as well (Kuhfeld, 2006). The ability to explore hypothetical non-existent scenarios is another advantage of this method (Vega and Alpízar, 2011).

A DCE consists of a list of key characteristics, or attributes, describing an alternative. Each of these attributes has different values, or levels, defining the configuration of that alternative. Several alternatives, 2 or 3 at a time, are presented at the same time to respondents in a choice set. Then, respondents are asked to analyze and choose their preferred one from each choice set (Louviere et al., 2000). An orthogonal experimental design ensures that each choice set is presented to respondents enough times, allowing researchers to estimate respondents' preferences for the attributes and all the levels that defined those alternatives.

The DCE estimates the utility[4], or satisfaction that respondents derive from a choice, which, in this case, is a potential management scenario. Also, the DCE allows valuing not only the resource as a whole but also the incremental worth of its components—i.e., the marginal part-worth utility[5] of its attributes (Birol et al., 2006) and their Relative Importance, RI (Vermunt and Magidson, 2005). DCEs are commonly used to forecast likely changes in behavior as a reaction to changed circumstances or to the hypothetical availability of certain goods (Louviere et al., 2000). The utility estimates from the DCE represent the utility that a level or unit of an attribute provides. When the attribute is categorical, this is measured as utility relative to the mean of the other levels from the same attribute. When the attribute is numerical, the interpretation of utility is on a "per unit" basis. The RI of an attribute, also known as Relative Maximum Effect, is the proportion of the overall utility explained by a change of one unit of that attribute when numeric, or from the difference between the least and most preferred levels of that attribute when categorical (Crouch and Louviere, 2004; Casini et al., 2016). The higher the RI value of one attribute, the

[4]Utility is defined as the weight of outcomes in making a decision (Ariely et al., 2003). It can also be explained as the level of short-term happiness derived from a specific material or immaterial good (Kimball and Willis, 2006). DCEs quantify utility by a mean-centered dimensionless value representing the preference associated with a particular level of an attribute compared with the reference level.

[5]Marginal part-worth utility is a measure of welfare that the respondent derives from a one-unit increment (all else being equal) of one attribute from the choice set (Steinke and Van Etten, 2017).

TABLE 2 | Demographics from the monarch enthusiasts' sample ($n = 331$).

Demographic variable			Demographic variable		
Gender	**Canada**	**US**	**Household size**	**Canada**	**US**
Female	15.2%	31.7%	1 Person	4.6%	9.5%
Male	21.1%	30.6%	2 Persons	11.7%	19.0%
Other	0.8%	0.5%	3 Persons	7.0%	15.2%
			4 Persons	9.5%	13.8%
Age	**Canada**	**US**	5 Persons	2.7%	4.3%
19	1.9%	1.9%	6 Persons	1.4%	0.5%
21–24	4.9%	2.4%	7 Persons	0.3%	0.0%
25–34	7.6%	19.2%	8 Persons	0.0%	0.3%
35–44	8.7%	15.2%			
45–54	3.8%	6.5%	**Level of income**	**Canada**	**US**
55–64	7.0%	11.4%	<$24,999	2.7%	5.1%
65 or more	3.3%	6.2%	$25,000–$34,999	1.4%	3.8%
			$35,000–$49,999	3.5%	5.4%
Educational attainment	**Canada**	**US**	$50,000–$74,999	5.7%	12.7%
Elementary or middle school graduate (grades 1–8)	0.3%	0.3%	$75,000–$99,999	6.2%	13.6%
High school graduate (grades 9–12)	4.1%	6.2%	$100,000–$149,999	8.4%	12.2%
Some post-modified education	5.4%	7.0%	$150,000–$199,999	2.2%	4.3%
Bachelor's degree	13.8%	17.1%	$200,000 or more	2.4%	3.0%
College or trade certification	7.3%	10.8%	No response	4.6%	2.7%
Graduate, post-doctoral or professional degree	6.2%	21.1%			
			Region		
			Central United States	32.3%	
			North United States	31.5%	
			South United States	26.3%	
			Other	9.9%	

more such attribute influences the preference of the respondent (Crouch and Louviere, 2004; Casini et al., 2016).

By including a contribution attribute within the experimental design, it is also possible to estimate a marginal willingness to pay (WTP) for each attribute (Kerr and Sharp, 2009). Taking advantage of this possibility, the estimates reported within this paper are in USD value. These estimates reflect the economic value of changing any attribute by one unit while leaving the remaining attributes fixed. The WTP presented here is a marginal WTP estimate on a per-unit basis from the baseline, which is different from the total WTP provided by other methods such as Contingent Valuation (Diffendorfer et al., 2013). Instead, the marginal WTP provided here denotes the difference in the contribution that the respondent would be willing to pay from the unweighted average of all the levels, for categorical variables (Daly et al., 2016). For numerical variables, it describes the difference of the respondent's WTP to increase one unit of a particular attribute while leaving the rest of the attributes fixed (Kerr and Sharp, 2009). This manuscript explores for the first time the marginal WTP for the monarch conservation.

Discrete Choice Experiment Design

We constructed choice alternatives describing potential management scenarios for the conservation of the monarch using a list of attributes that described a hypothetical ecological status of the monarch, and the strategic-level characteristics of a proposed conservation initiative. These attributes were refined using input from interviews with academics with expertise in human dimensions, conservation biology, or both. The final alternatives were made up of nine[6] attributes, three of them as context and the other six as program attributes (**Table 3**). Values for the levels of each attribute were selected based on feedback from academics, two focus groups, and a pilot study with 200 respondents (100 Canadians and 100 US citizens) 2 months prior to the final version release. The first focus group ($n = 8$) consisted of experts on this method, with the primary objective of finding technical deficiencies. The second focus group ($n = 13$) was composed of graduate students of the authors' universities with differing levels of familiarity with choice experiments or the monarch and sought feedback about the size and complexity of the survey. Finally, the pilot study was directed to the same demographics as the target population of the main survey and sought to detect cognitive fatigue, such as positive WTP estimates, lack of

[6]The context attributes that appeared in the survey were "Trend" and "Area-Trend." The attribute "Area" did not appear in the survey, but it was used to calculate the "Area-Trend" attribute (which is an interaction between "Area" and "Trend"). Also, the "Payment Vehicle" and "Leader" are part of a single attribute in the experimental design but appear separately in the survey. See **Table 3** for details.

TABLE 3 | Attributes and levels used in the choice experiment exercise.

Type		Name	Attribute	Levels	Description
Program attributes	Categorical	Leader	Institution leading the program	Local NGO, International NGO, Federal Government, Educational Institution	Type of organization in charge of the conservation program
		Payment vehicle	Fund-raising mode	Tax, donation	Payment method through which the institution leading the program would gather the funds contributed by the respondent. This attribute is linked to "Leader" (considered as one in the experimental design). When "Leader" showed "Federal Government," this attribute displays "Tax." For the rest, the "Payment Vehicle" was "Donation"
		Resource allocation	The country where the raised funds will be used	My country, The other country, Mexico, The three countries	Form in which the funds contributed by the respondent would be distributed amongst Canada, the US, and Mexico. "The other country" level appeared different for Canadian and US respondents (e.g., a US respondent with "The other country," would read "Canada"). The same situation for "My country" level
Context attributes	Numeric	Research	Funds dedicated to research and citizen science activities	0%, 10%, 25%, 50%	Percentage of the program's funds that would be dedicated to supporting research and citizen science activities relative to funds dedicated to "on-the-ground" activities.
		Expected success	The probability of success of the program	30%, 50%, 70%, 90%	Chance that the program described would be effective after 10 years of implementation
		Contribution	Economic contribution (USD)	5, 15, 30, 50, 70, 100, 140, 200	Yearly contribution (Donation or tax depending on "Payment Vehicle") for supporting the described program
		Colonies' trend	Trend of the colonies for the past 5 years	−40%, −20%, 0 % (stable), 20%	Percent change of the overwintering colonies' area for the last 5 years with respect to the current area
		Colonies' area	Area of overwintering colonies (Hectares)	0.5, 1.5, 3.0, 4.0	Hypothetical area currently occupied by the overwintering monarch colonies in Mexico as a proxy of population size
		Area-trend	Change of the colonies over the past 5 years (Hectares)	−1.60, −1.2, −0.8, −0.6, −0.3, −0.2, −0.1, 0, 0.1, 0.3, 0.6, 0.8	Interaction term between Colonies' Area and Colonies' Trend

significance of the utility estimates, or extensive skipping of optional screens.

Each choice set (**Figure 2**) consisted of an ecological context scenario with three attributes, and three options: two alternative conservation programs, and one *status quo* option. Context attributes established the scenario under which the respondents would be making their choice (Tversky and Simonson, 1993; Haegeli et al., 2012). Here, the context attributes set a hypothetical situation of the overwintering colonies to investigate the change of respondents' preferences with the assumption that respondent preferences were context-dependent (Mazar et al., 2014). These context attributes remained the same for all options of the choice set and only changed between choice sets.

The program attributes included international allocation of funds, probability of success of the program, institution leading the program, monetary contribution to the described program, fund-raising mode, and percentage of funds dedicated to research and citizen science activities. These attributes varied their levels independently from each alternative so that the respondent could perceive a contrast between the options. The "*status quo*" option as a base alternative consisted of abstaining from contributing to any program and maintaining the current trend shown in the specific scenario. Most literature agrees that a base alternative has to be included to estimate the welfare change associated with the other alternatives (Bateman et al., 2004; Train, 2009). If the respondent chose the base alternative in any of the presented choice sets, they were asked to provide a rationale for their choice.

The experimental design for the main urban residents' survey was a $4^6 \times 8^1$ orthogonal fractional factorial design with two of those factors entered as context variables. For the modified urban

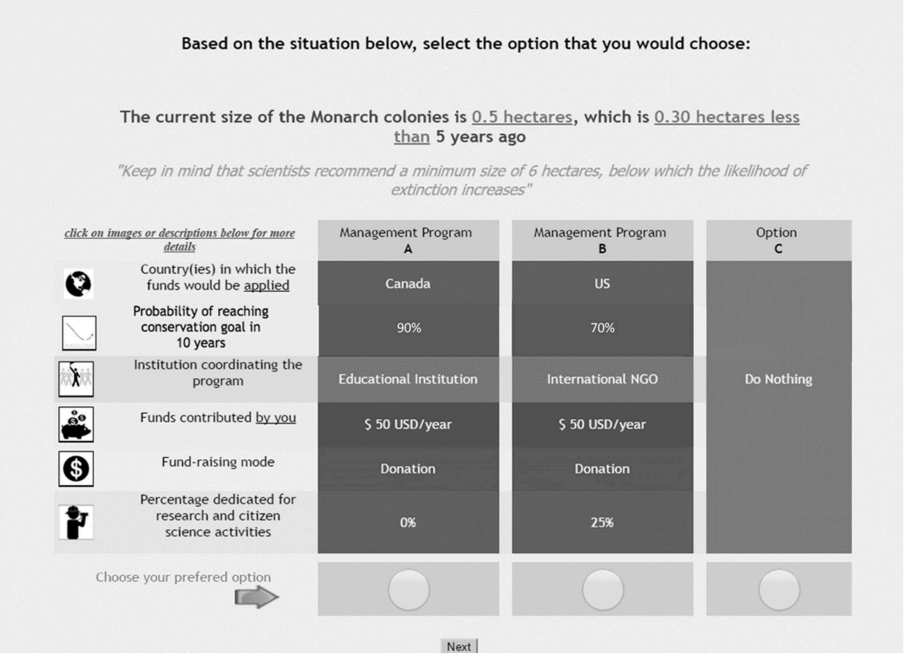

FIGURE 2 | Example of the choice experiment. Each management-program scenario showcases a different configuration of options, based on an orthogonal fractional factorial design. The top part of the screen, describing the hypothetical current situation of the monarch's population, appears on the screen 7 s before the management strategy to ensure that respondents read the information concerning the population trend. Respondents must select their preferred management strategy or to do nothing (alternative, "Option C").

resident's survey, a new design with the same characteristics was generated but with one factor removed ($4^5 \times 8^1$). Both designs were generated with the SAS "*%MktEx*" Macro (Kuhfeld, 2001) and had a D-efficiency of 100% as a measure of the design's goodness (efficiency), and orthogonality (Kuhfeld et al., 1994).

Statistical Analyses

All the numeric levels were standardized and centered before analyzing the DCE model. The data were analyzed using conditional logit and latent class regression with Latent Gold 3.0 software (Vermunt and Magidson, 2005), obtaining Relative Importance (RI), latent class segmentation outputs, and model performance metrics.

Latent Class Analysis (LC) was used to identify and segment heterogeneity in utility estimates among urban residents. The LC assumes that the sample constitutes a finite number of groups of individuals, also known as classes, with relatively similar preferences within their group and considerably different from each other (Birol et al., 2006). Random Parameters Logit can also identify the heterogeneity of preferences within a sample (McConnell and Tseng, 1999); however, Random Parameters Logit elicits the individual differences amongst the sample rather than grouping them (as LC does). The latter scale of analysis is considered more convenient for the design of management strategies (Boxall and Adamowicz, 2002).

The non-significantly different attributes across classes in preliminary models were constrained to be the same across all classes to prioritize the delineation of classes by the most highly variable attributes (**Table 5**). That model restriction reduced the number of parameters and improved the fit of the model (Vermunt and Magidson, 2000).

Embedding a DCE within a comprehensive survey allows descriptive data, as covariates or predictors, to define individuals by linking these with their preferences. Covariates are *a posteriori* explanatory variables that describe class membership and can inform the policymaker about which demographic strata can be targeted with specific actions (Boxall and Adamowicz, 2002). Covariates included in the model were the pre-survey knowledge about milkweed and the monarch's status, whether the respondent was engaged in any ecological/citizen science activity, and the age group of the respondent.

Alternatively, predictors are characteristics of the choice replication or the person and have the same value across alternatives. Predictors are part of the regression model, just like attributes, and are therefore considered *a priori* explanatory variables (Vermunt and Magidson, 2005). As a result, covariates can predict class membership, whereas predictors contribute to its creation. Here, the model included the level of concern about the monarch's situation as a predictor.

For the three respondent samples (main urban residents, monarch enthusiasts, and the modified sample of urban residents), we also conducted a Multinomial Logit Model (MNL) analysis to obtain a one-class model for each. These types of models are suitable for observing the main trends of the sample without accounting for heterogeneity. The MNL was used to compare the three samples and qualitatively detect

any differences between the general preferences of people engaged—or not—in ecological activities (urban residents vs. monarch enthusiast's sample), or between people provided with an expected probability of success—or not—of the proposed program (main urban residents' vs. modified urban residents' sample).

To control for the uneven spacing of some of the numeric-variable attributes and to achieve more interpretable results, we linearized all our numeric attributes (Kohlhardt et al., 2018). All the categorical attributes were effects coded for the interpretation of their estimates (Daly et al., 2016). Numeric data were analyzed with one-way ANOVA and a *post hoc* Tukey's Honest Significant Tests. For categorical data, a Pearson's chi-squared test was used. All statistical treatments were done with JMP 13 (SAS Institute Inc, 2016), and R 3.51 (R Core Team, 2013) was used to plot the results.

RESULTS

Latent Class Analysis of Main Urban Residents

Description of Classes

Preliminary models with different number of classes, covariates, predictors, and constraints (**Table 4**) were defined and evaluated using Bayesian Information Criteria (Burnham and Anderson, 2004). We also built a preliminary 2-known-class model based on nationality, and no significant differences were found between the classes regarding their preferences for the attributes presented; we pooled the data as a result. The final model was a three-class model with significantly different preferences for the geographical allocation of the resources, sensitivity toward the allocation of funds across classes, and the Alternative Specific Constant (ASC), which can be described as the utility derived from selecting any choice different from the *status quo* without accounting for the specific levels of the rest of the attributes. Each class was labeled based on those differences as "Eager," "Pro-Nation," and "Opinionated." The final model had the "Leader," and "Area" attributes constrained between class "Eager" and "Pro-Nation," "Research" across "Eager" and "Opinionated," and "Trend" across the three classes (**Table 5**). The "Eager" group was the largest, making up 72.4% of the overall sample. The "Pro-Nation" class was second in size (18.37%) and "Opinionated" was the smallest (9.23%)[7].

Individuals from the class "Eager" showed a large estimate for the ASC, which represents a strong motivation to support conservation initiatives regardless of the configuration of the choice set (**Table 6**). In contrast, the other two classes denoted an unwillingness to participate in any management program. People from the "Pro-Nation" class strongly based their decisions on the allocation of funds across countries. When the choice task indicated that the allocation of funds would favor the respondent's country of residence, their utility markedly rose. In contrast, when funds were allocated only to Mexico or to the "other country," i.e., the US for Canadians, or Canada for US citizens, their utility considerably decreased in comparison to the other two classes. This class had a difference between the highest and lowest valued estimates 34.4% larger than that of "Eager." Finally, the third and smallest class was labeled "Opinionated" due to the large estimates associated with the leading institution, resources allocation, and especially the economic contribution. This class also had the most negative ASC, implying that they are the most reluctant to participate in any management program.

Respondents in the "Eager" group displayed the highest NEP score, indicating that these individuals possess largely pro-environmental attitudes. They tended to be younger and had a higher level of education, where 82.6% obtained at least a bachelor's degree, furthermore, 17.1% had a graduate certificate. Their income level was also higher than the other two classes, where 62.4% of the group earned at least $50,000 per annum and also had the largest household size. The "Eager" class had the most considerable share of people contributing to ecologically oriented NGOs and actively participating in ecological conservation meetings, protests, and lectures. However, 58.5% of the people participating in those activities did not contribute economically to any ecologically oriented NGO (**Tables 7**, **8**).

The "Pro-Nation" and "Opinionated" classes were similar in attitudinal preferences and demographics, except in the percentage of individuals contributing to environmentally related activities and in age. Also, a higher proportion of the "Pro-Nation" class contributed to ecologically oriented organizations in comparison with people from the "Opinionated" class.

Only the level of concern about the monarch situation was included as a predictor of choice in the definition of the model as it significantly improved model fit. The overall utility estimates for "Eager" and "Pro-Nation," which add up to 91% of the overall sample, were positively affected when respondents had a higher level of concern about the monarch's situation. The reaction of "Opinionated" was counterintuitive, where its overall utility was negatively affected by an increase in their level of concern.

Context Attributes' Estimates

Further interpretation of the classes can be made by considering the attributes themselves and their levels (for a full list of estimates refer to **Table 6** and **Figure 3**). Respondents reacted to the percentage change of the overwintering monarch colonies' size over the last 5 years, in relation to the current area, similarly negative across the three classes, and all respondents' interest in supporting management programs decreased when the monarch population trend increased.

For the current area of the overwintering colonies, the "Eager" and "Pro-Nation" classes reacted similarly. They both were significantly affected negatively by the increase of the area of the overwintering colonies, i.e., their interest in supporting management programs decreased when the current colony population was higher. For the "Opinionated" class, we found the opposite effect. All the "Area" estimates were significant only at the 10% level.

[7]A LC provides the posterior probability that an individual belongs to a certain class (McCutcheon, 1987). We assumed that the class membership of a respondent was dictated by the class that gave them the highest posterior probability (Pacifico and Yoo, 2013).

TABLE 4 | Model selection for the main urban resident sample ($n = 1,859$).

	# of Classes	LL	BIC (LL)	AIC(LL)	L^2	Npar	df	Significance	Class.Err	R^2 (0)	R^2
1-Class base model	1	−6,925	13,964	13,881	13,848	15	1,821	***	–	0.2	0.1
2-Class base model	2	−5,921	12,114	11,915	11,841	36	1,800	***	0.02	0.4	0.3
3-Class base model	3	−5,826	12,082	11,767	11,650	57	1,779	***	0.08	0.4	0.4
4-Class base model	4	−5,768	12,123	11,693	11,534	78	1,758	***	0.22	0.5	0.5
5-Class base model	5	−5,725	12,195	11,649	11,448	99	1,737	***	0.28	0.5	0.5
6-Class base model	6	−5,682	12,267	11,605	11,362	120	1,716	***	0.29	0.5	0.5
7-Class base model	7	−5,634	12,328	11,550	11,265	141	1,695	***	0.30	0.6	0.5
8-Class base model	8	−5,601	12,419	11,525	11,199	162	1,674	***	0.30	0.6	0.6
3-Class 2nd model	3	−5,827	12,061	11,763	11,652	54	1,782	***	0.09	0.4	0.4
3-Class 3rd model	3	−5,827	12,053	11,761	11,652	53	1,783	***	0.09	0.4	0.4
3-Class 4th model	3	−5,828	12,048	11,761	11,654	52	1,784	***	0.08	0.4	0.4
3-Class 5th model	3	−5,828	12,040	11,759	11,654	51	1,785	***	0.08	0.4	0.4
4-Class 2nd model	4	−5,772	12,070	11,684	11,541	70	1,766	***	0.22	0.5	0.5
4-Class 3rd model	4	−5,774	12,059	11,684	11,545	68	1,768	***	0.22	0.5	0.5
Final model (3-class)	3	−5,829	12,034	11,758	11,655	50	1,786	***	0.08	0.4	0.4

*The base models have no restrictions, whereas subsequent models (with the same number of classes) are variations of that first model with different combinations of constraints, covariates, and predictors. Model selection was based on the best (lowest) BIC and smaller classification error (Class. Err). ***1% significance level with two-tailed tests.*

TABLE 5 | Definition of constraints for the 3-latent class model of the main urban resident's sample ($n = 1,859$).

	Class	Eager	Pro-Nation	Opinionated
Program attributes	ASC	A	B	C
	Leader	A	A	C
	Resource allocation	A	B	C
	Research	A	B	A
	Success	A	B	C
	Contribution	A	B	C
Context attributes	Trend	A	A	A
	Area	A	A	C
	Area-trend	A	B	C

Classes with similar preferences on preliminary models for a particular attribute were assumed to be the same in the final model, so other attributes with higher variance could drive the splitting of classes. Classes with the same letter denote that they have the same estimate for that specific attribute.

As described in **Table 3**, the "Change" attribute was an interaction attribute between the overwintering colonies' Trend and Area. Respondents from the "Eager" class derived a positive utility from this attribute, i.e., the more substantial the increase, the higher the interest in supporting management programs. "Pro-Nation" respondents derived a negative utility, and "Opinionated" respondents were not significantly affected by this attribute.

Program Attributes' Estimates

The estimates for the institution leading the program were equal across "Eager" and "Pro-Nation." For these two classes, International NGOs and Educational institutions were significantly positive. Alternatively, "Opinionated" respondents showed a preference for local NGOs as leaders of the program. In all cases, the least preferred leading institution was the federal government.

When the allocation of resources was distributed to the respondent's own country, the utility estimates were the highest for the "Pro-Nation" class. The utility of the "Pro-Nation" and "Eager" classes became negative when either Mexico or the counterpart North American country were the receivers of those resources. Respondents from the "Opinionated" class were only significantly negatively affected when the counterpart country was the beneficiary of the resources. When the resources were distributed equitably across the three countries, the attribute's estimates were the highest for the "Eager" and "Opinionated" classes.

Regarding the percentage of funds dedicated to research and citizen science activities, the utility was similarly negative across the "Eager" and "Opinionated" classes and not significant for "Pro-Nation." For the probability of reaching the conservation goal of a minimum size of 6 ha for the overwintering colonies in 10 years, the utility estimates for "Eager" and "Pro-Nation" were significant and positive but being the first double than the latter; "Opinionated" had no significant preferences.

Finally, the attribute asking for the amount of money that respondents would be willing to donate for supporting the selected management strategy was negative and highly significant for all three classes. However, the "Opinionated" class estimate was almost double than that of "Pro-Nation" and almost 10-fold than that of "Eager" respondents.

Monarch Enthusiast's Estimates

The monarch enthusiasts sample ($n = 331$) consisted of individuals from the main urban residents' sample that self-reported as being monarch enthusiasts, and people from the DPLEX Monarch Watch mailing list. The primary objective of this sample was to identify differences between this group

TABLE 6 | Latent class (3 classes) estimates and Marginal Willingness to Pay (mWTP) for the main urban residents' sample.

			Latent Class (3 Classes)											
			Eager				Pro-Nation				Opinionated			
			Class size = 72.4% (n = 1,345)				Class size = 18.37% (n = 341)				Class size = 9.23% (n = 172)			
Type	**Attributes**	**Levels**	**Estimate**		**mWTP ($)**	**RI (%)**	**Estimate**		**mWTP ($)**	**RI (%)**	**Estimate**		**mWTP ($)**	**RI (%)**
Program attributes	ASC	Alternative A or B	1.22	***	10.17	30	−1.23	***	−1.92	21	−1.45	***	−1.22	16
		None	−1.22	***			1.23	***			1.45	***		
	Leader	Local NGO	−0.03		−0.25	4	−0.03		−0.05	3	0.76	***	0.64	8
		International NGO	0.1	***	0.83		0.1	***	0.16		0.34		0.28	
		Educational institution	0.14	***	1.17		0.14	***	0.22		−0.36		−0.30	
		Federal government	−0.21	***	−1.75		−0.21	***	−0.33		−0.73	**	−0.62	
	Resource allocation	Mexico	−0.36	***	−3.00	11	−0.71	***	−1.11	12	0		0.00	7
		The other country	−0.41	***	−3.42		−0.44	***	−0.69		−0.82	***	−0.69	
		The three countries	0.51	***	4.25		0.47	***	0.73		0.45		0.38	
		My country	0.26	***	2.17		0.69	***	1.07		0.36		0.30	
	Numeric variables	Research	−0.1	***	−0.83	5	−0.01		−0.02	0	−0.1	***	−0.08	2
		Expected success	0.34	***	2.83	17	0.17	***	0.27	6	0.01		0.01	0
		Contribution	−0.12	***		12	−0.64	***		44	−1.19	***		54
Context attributes		Colonies' trend	−0.18	***	−1.50	9	−0.18	***	−0.28	6	−0.18	***	−0.15	4
		Colonies' area	−0.07	*	−0.58	3	−0.07	*	−0.11	2	0.27	*	0.23	6
		Area-trend	0.09	**	0.75	9	−0.1	**	−0.16	7	−0.05		−0.04	2
Predictors	Concerned about the Monarch's Situation?													
	No	A	−0.17	***			−0.76	***		–	0.71	***		
		B	−0.16	***			−0.72	***		–	0.79	***		
		None	0.32	***			1.48	***			−1.5	***		
	Yes	A	0.17	***			0.76	***			−0.71	***		
		B	0.16	***			0.72	***		–	−0.79	***		
		None	−0.32	***			−1.48	***		–	1.5	***		
Covariates	Engaged in Citizen Science/Ecological Activities?													
	No		−0.25	***			0.16				0.09			
	Yes		0.25	***			−0.16				−0.09			
	Age Group													
	Between 25 and 4		0.07				−0.09				0.02			
	Less than 25		0.51	***			−0.06				−0.45			
	More than 45		−0.58	***			0.15				0.43	***		
	Aware of Milkweed Role?													
	Yes		0.16	***			−0.06				−0.11			
	No		−0.16	***			0.06				0.11			
	Aware of Monarch's Situation?													
	Yes		0.24	***			−0.12	*			−0.13	*		
	No		−0.24	***			0.12	*			0.13	*		

*See text for the definition of Relative Importance (RI). ***1% significance level, **5% significance level, *10% significance level with two-tailed tests. The Attribute "Area-Trend" is an interaction attribute between "Area" and "Trend".*

TABLE 7 | Numeric explanatory factors that describe the three latent classes of the main urban resident's sample (n = 1,859).

Explanatory factor	Eager (n = 1,345)		Pro-Nation (n = 341)		Opinionated (n = 172)	
	Mean	s.e	Mean	s.e	Mean	s.e
Age	43.18	0.40	50.81	0.88	51.99	1.17
NEP score	100.85	0.61	94.75	1.35	93.66	1.78
Household size	2.82	0.04	2.57	0.08	2.60	0.10

We tested the differences between classes with a one-way ANOVA test and post hoc Tukey's test and the class "Eager" was significantly different (P < 0.001) to the other two classes, which were no significantly different between each other.

TABLE 8 | Nominal demographic variables describing the three latent classes from the main urban residents' sample (n = 1,859).

Item	Eager (n = 1,345) Yes (%)	Pro-Nation (n = 341) Yes (%)	Opinionated (n = 172) Yes (%)	X^2
Participate in nature conservation/citizen science activities	18.96	6.71	4.14	50.82***
Participate in conservation or citizen science activities related to the monarch	2.89	0.61	0.34	9.24***
Attended an environmentally-related meeting, lecture, or protest	19.01	5.52	6.75	45.62***
Member of, or a donor to, an environmental organization	16.40	8.62	2.44	34.86***
Graduate degree	17.09	12.07	9.15	20.29**
High school degree	16.58	18.97	23.78	20.29**
Male respondents	43.92	50.69	48.17	6.54
US respondents	48.77	52.07	49.39	1.04

****1% significance level, **5% significance level.*

and the main urban residents' sample. For this sample, the estimates obtained from the MNL (**Table 9**) closely resembled the estimates from the "Eager" class of the main urban residents' sample with the following exceptions: this sample showed a positive utility for the type of institution leading the program only when it was an educational institution. The remaining levels did not significantly affect the monarch enthusiasts' choice, unlike "Eager" respondents that had significantly positive estimates for both international NGOs and educational institutions. Also, while in the main urban residents' sample each of the classes had significant estimates for at least one of the context attributes ("Area," "Trend," or "Area-Trend"), the monarch enthusiasts did not exhibit significant preferences for any of them. Lastly, the estimate for the monetary contribution to support the program was negative (just as with the main urban residents' sample), but the value of the attribute was noticeably smaller in magnitude.

The ANOVA test shows that the demographics of this sample were significantly different from the main sample and each one of the three classes. A more substantial proportion of monarch enthusiasts were engaged in ecologically-related activities ($p < 0.001$) as well as the percentage of them who contributed to ecologically-oriented NGOs ($p < 0.001$). The percentage of enthusiasts that were Canadian was significantly lower than the share of Canadians from the urban residents' sample ($p < 0.001$). Respondents from the monarch enthusiasts' sample also had a higher level of education ($p < 0.001$), although the income level was not significantly different. Unlike the main sample that had more females than males, the citizen scientists' sample had a significantly higher proportion of males ($p = 0.007$). Finally, the average age of the enthusiasts' sample averaged significantly ($p < 0.001$) lower than the urban resident's sample (**Table 2**).

Modified Urban Resident's Estimates (Success Omitted)

The attribute most influenced by the inclusion/exclusion of a success probability was the percentage of resources dedicated to research. When included, the utility estimate of contributing funds to research was negative, i.e., respondents from the main urban sample were less willing to provide funds toward research when the program specified an expected success. Conversely, with the removal of this attribute, the estimate for research became positive; i.e., contribution-support increased in the absence of knowing success. However, amongst the respondents from the modified sample, the ASC value was negative, denoting a decrease of willingness to support conservation measures overall (**Table 9** and **Figure 4**).

Willingness to Pay

The marginal willingness to pay (mWTP) for each of the attributes was calculated and is shown in **Table 6**. The mWTP is defined as the difference in the contribution that the respondent would be willing to pay from the mean of all the levels, for categorical variables (Daly et al., 2016) and the difference of the respondent's WTP to increase one unit of a particular attribute while leaving the rest of the attributes fixed (Kerr and Sharp, 2009). Finally, the total WTP to support a conservation program for the monarch was also estimated. The WTP was contingent on the configuration of the program[8] and followed the utility estimates described in previous sections and, based on the

[8]The configuration of the "Best program" was defined as a program with the levels that obtained the higher utility estimate for each of the categorical attributes, with 90% success, and 20% of funds dedicated to research. Conversely the "Worst program" used the levels with lower utility, had 70% success, and also dedicated 20% of funds to research.

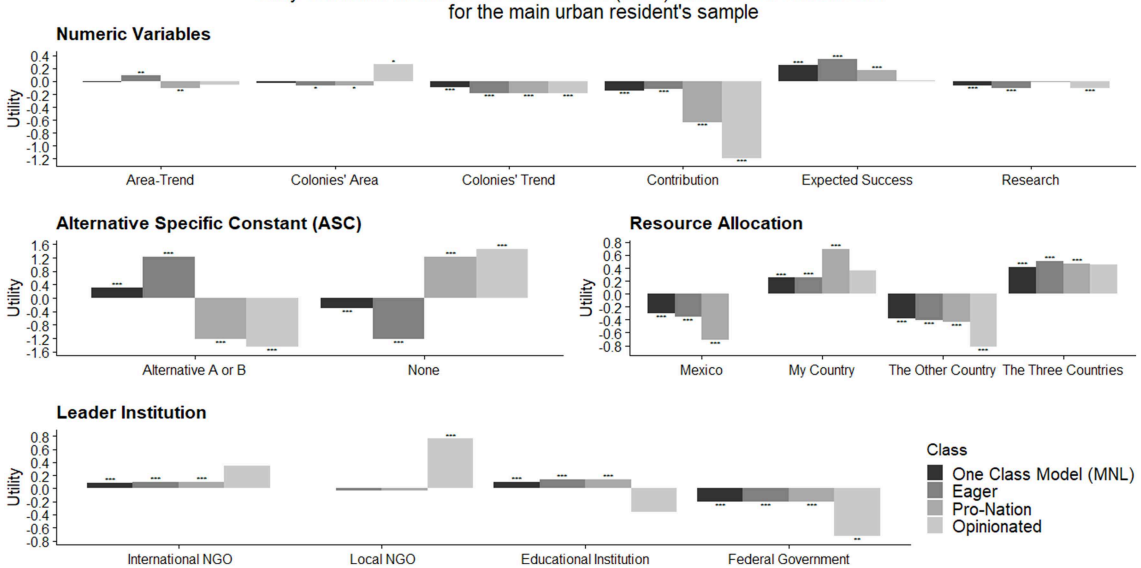

FIGURE 3 | Utility estimates for the one class model (MNL) and 3-latent class model for the main urban resident's sample. The y-axis is a dimensionless representation of the utility derived from a specific level of an attribute. The Alternative Specific Constant (ASC) represents the willingness to support the program regardless of its configuration. ***1% significance level, **5% significance level, *10% significance level with two-tailed tests.

current area and trend of the overwintering colonies (Rendón-Salinas et al., 2019), it ranged between $100.41 and $141.01 for the worst and best program configurations, respectively. When analyzing each of the classes, the average WTP was $161.76, $76.85, and $-5.04 for the classes "Eager," "Pro-Nation," and "Opinionated," respectively.

DISCUSSION

The monarch butterfly is an iconic species for people from the US, Canada, and Mexico alike (Guiney and Oberhauser, 2008). As such, its conservation provides an excellent opportunity to find common points of interest and strengthen, or create, institutions of tri-national cooperation for the recovery of the monarch and other transboundary migratory species as well (Lopez-Hoffmann et al., 2009). Moreover, the monarch's plight has mobilized a considerable number of urban residents across the three countries to participate in habitat restoration and citizen science efforts to protect it (Ries and Oberhauser, 2015). The role of small habitat providers and citizen scientists that urban residents play in this context also extend to conservation-policy support. Conservation practitioners should strive to find the most effective ways to funnel this potential capacity, with that objective, and this study aimed to determine urban-resident preferences toward strategic-level characteristics of a management strategy for monarch conservation that would generate the highest amount of support from urban residents.

We found that people across the main eastern breeding range of the monarch, represented by the eastern United States and the province of Ontario, share preferences concerning their inclination for non-governmental leadership in conservation programs, and joint international cooperation. Nonetheless, within-respondent sample heterogeneity was identified. Additionally, people currently engaged and non-engaged in ecological activities had marked differences over the identity of leaders of a conservation program, as well with their sensitivity toward ecological issues. Lastly, the knowledge about the success of a conservation program proved to also play an influential role in guiding people's preferences, albeit we acknowledge the challenge in ascribing a probability of success for conservation actions. All these findings, discussed below, have direct and relevant policy implications that can affect the adoption and support of conservation programs for the monarch and other migrating North American species.

Institutional Leadership

There was a clear tendency across the three classes for choosing any other alternative as a leader before the federal government. Previous research directly compared people's perception about different types of institutions spearheading conservation programs (Wells, 1998), exploring the distrust of people toward the federal government in the United States (Brook et al., 2003), Canada (Parkins et al., 2017), and elsewhere (Chen and Hua, 2015) within a conservation context. A common finding was that distrust was mainly credited to the perception of a lack of accountability and effectiveness with regards to the exercise of conservation funds by the government (Chen and Hua, 2015). Similarly, studies have found distrust with non-government organizations as well, mainly due to

TABLE 9 | Estimates and marginal Willingness to Pay (mWTP) for the Multinomial (MNL) choice models obtained from the main urban resident's sample with the attribute "Success" included (n = 1,859), the modified urban resident's sample with "Success" attribute removed (n = 659), and the monarch enthusiasts' samples (n = 331).

			Main urban resident's			Modified urban resident's			Monarch enthusiasts		
Type	**Attributes**	**Levels**	**Estimate**	**mWTP ($)**		**Estimate**	**mWTP ($)**		**Estimate**	**mWTP ($)**	
Program attributes	ASC	Alternative A or B	0.3	1.99	***	−0.67	−4.53	***	0.9	12.47	***
		None	−0.3		***	0.67		***	−0.9		***
	Leader	Local NGO	0.01	0.06		0.08	0.46		−0.02	−0.22	
		International NGO	0.09	0.59	***	0.19	1.17	***	−0.03	−0.49	
		Educational institution	0.1	0.67	***	−0.03	−0.18		0.12	1.66	*
		Federal government	−0.2	−1.32	***	−0.24	−1.44	***	−0.07	−0.96	
	Resource allocation	Mexico	−0.3	−2.00	***	−0.41	−2.47	***	−0.42	−5.83	***
		Other country	−0.38	−2.59	***	−0.35	−2.14	***	−0.49	−6.82	***
		Three country	0.42	2.87	***	0.53	3.25	***	0.56	7.86	***
		My country	0.25	1.72	***	0.23	1.37	***	0.34	4.80	***
	Numeric variables	Research	−0.07	−0.45	***	0.15	0.88	***	−0.14	−1.92	***
		Success	0.25	1.66	***	Removed	Removed		0.31	4.30	***
		Contribution	−0.15	−1.00	***	−0.16	−1.00	***	−0.07	−1.00	***
Context attributes		Trend	−0.09	−0.60	***	0.04	0.22		−0.08	−1.14	
		Area	−0.03	−0.17		−0.03	−0.20		−0.06	−0.86	
		Area-trend	−0.02	−0.15		−0.01	−0.04		0.01	0.20	

****1% significance level, *10% significance level with two-tailed tests.*

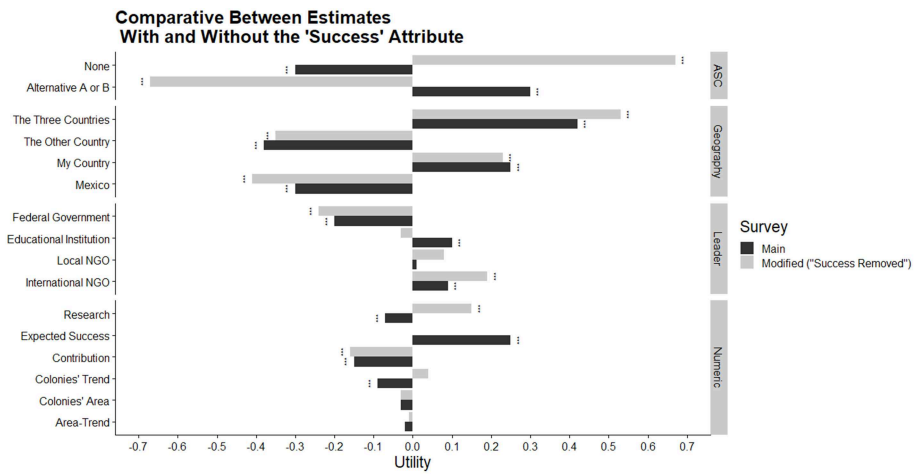

FIGURE 4 | Change in utility estimates for the MNL (one-class model) of the main urban resident and the modified urban resident (with "Success" attribute removed) samples. The x-axis is a dimensionless representation of the utility derived from a specific level of an attribute. ***1% significance level with two-tailed tests.

discrepancies between their mission statements and on-the-ground actions, combined with the perception of being profit-driven organizations (Arenas et al., 2009). As such, the sense of trust, respect, and credit people have for conservation institutions, whether NGO or government-related, can vary widely (Jepson, 2005). However, there is a general trend of respondents preferring NGOs and educational institutions over the federal government as leaders of monarch conservation programs. Considering that urban residents are a substantial majority in Canada and the US, and reflected in the present study, we concur with the recommendations of Amano et al. (2018) on effective governance. Specifically, that governments should continue to decentralize their decision-making and community engagement processes while also encouraging broader and more coordinated participation of non-government actors in the conservation of the monarch and other species across North America.

The preference for NGO leadership within the monarch conservation context may be explained by the extensive and meaningful contributions of NGOs across the overwintering sites (Carlos Galindo-Leal, 2005; Oberhauser et al., 2008; Valera-Bermejo, 2009; Solís, 2012), migratory flyway (Urquhart and

Urquhart, 1976), and breeding grounds (Ries and Oberhauser, 2015). While further research would be needed to verify the awareness of monarch-related NGOs amongst urban residents, NGOs dedicated to monarch conservation have provided valuable opportunities for public engagement through citizen science activities, although at a smaller scale educational institutions, zoos and aquariums, and governments, work with citizen scientists as well. Indeed, 17% of 503 monarch-related research published over the last 74 years has relied to a certain extent on citizen science (Ries and Oberhauser, 2015). Our findings, along with similar outcomes in birds (Horns et al., 2018) and pollinators (Kleinke et al., 2018) suggest that the engagement practices of monarch-related NGOs could serve as a template for other NGOs dedicated to other multinational conservation issues to foster trust and support in their fields.

International Implications

Most monarch research focuses on the overwintering sites in Mexico and the breeding grounds across the mid-west of the US. Although those are considered the most sensitive areas of the migratory cycle (Flockhart et al., 2015), the northern range of the migratory flyway also plays an important role, especially when the mid-western states of the US have lost much breeding habitat (Pleasants and Oberhauser, 2012), and the Canadian sites are presumably increasing in relative habitat availability (Lemoine, 2015). Furthermore, the northern range may become crucial with the potential northward range shift in light of climate change (Batalden et al., 2007).

The success of transboundary conservation programs increases in difficulty depending on the amount of socio-cultural differences between the parties involved (Kark et al., 2015). As such, it is crucial to document whether Canadians react to management strategies the same way as US citizens do, which had not been explicitly examined until now. Previous research shows considerable differences between Canadians and US citizens regarding their interaction with the environment (Leech et al., 2002) and their attitudes toward environmental investment (Lachapelle et al., 2012). However, at a finer grain of analysis, the heterogeneity of preferences, common to each country, make it very difficult to assume different attitudinal trends for Canadians and US citizens (Alston et al., 1996). Similar heterogeneity was found in the preferences across the two countries and revealed demographic and attitudinal variables such as age, level of education, and income could explain such heterogeneity better than nationality does. This finding will be essential to consider, not only for the design of new management strategies for the monarch, and presumably other North American transboundary migratory species, but also can help facilitate international institutions to improve their coordination efforts between their national offices.

The preferences for the attributes presented in the choice experiment between Canadian and US citizens yielded no significant differences, which anticipates a positive outcome for the design and success of transnational conservation strategies for the monarch. However, it is essential to note the absence of Mexico in this study, which should be the next stage of analysis. We acknowledge the presence of international institutions currently working in the monarch conservation context, such as the Commission for Environmental Cooperation (CEC), but further involvement is needed from governments, NGOs, and academia to promote efforts at the international scale. The relevance of the results presented here, aside from contributing to the available knowledge of Canadian/US behavioral traits, validates previous monarch research that assumes that preferences of Canadians and US citizens are similar (Flockhart et al., 2015; Oberhauser et al., 2017).

Conservation of transboundary migratory species requires not only the understanding of preference heterogeneity of the multiple actors involved but also needs to achieve cooperation amongst those actors to attain a common goal (Kark et al., 2015). Possible avenues for achieving such agreement were explored here by eliciting the respondent's preferences for the allocation of conservation funds either nationally or internationally. The two largest classes, accounting for 81.62% of the sample, derived almost twice the utility when the conservation funds were distributed across the three countries in comparison to when the funds stayed local. Such predilection for international allocation of funds is contrary to a case in foreign aid where the utility tended to be higher when a proposed program would fund local efforts (Okten and Osili, 2007). The social construct[9] that the monarch has become might well explain this discrepancy (Gustafsson et al., 2015), which has mobilized international conversations and policy development (Gustafsson et al., 2015). In light of these findings, the monarch's plight can be used to catapult it as a flagship species for other conservation efforts of migratory pollinator species in peril throughout North America, by designing multi-species conservation strategies for the protection of shared habitat as well as to provide nectar sources for many pollinator types across their range at the appropriate times (Guiney and Oberhauser, 2008).

Citizen Science and Public Engagement

The demographic, lifestyle, and attitudinal variables describing each of the classes provide insights into the willingness of people to participate in conservation programs. Individuals from the main residents' urban sample that self-reported as participants of conservation efforts had a higher sensitivity to environmental topics overall and were more likely to invest their resources in conservation efforts. Johnson et al. (2014) explain that these highly motivated individuals tend to turn into skilled leaders, transmitting skills and motivations to the rest of their social network. Congruently, people identified here to be already engaged in citizen science and environmental activities had a smaller utility overall for the economic contribution to the selected program in comparison with people not engaged in conservation. This finding suggests that ecologically engaged people "suffer" less for every dollar they invest in conservation. Interestingly, 60.6% of monarch enthusiasts reported not contributing economically to any environmental organization, implying that a lack of monetary contribution does

[9] Virtue ascribed to a subject by the general public (Czech et al., 1998).

not necessarily mean a lack of interest or absence of participation via other means. Therefore, providing opportunities to capture those types of non-monetary contributions such as community engagement, citizen science activities, and lobbying, may provide significant momentum to environmental causes.

When asked about funds dedicated to research and citizen science activities, this attribute had a negative estimate for monarch enthusiasts (indeed, for all respondents). This trait along with low estimates for the economic contribution for the selected program and high values for supporting monarch conservation in general, suggests that monarch enthusiasts are not resource-driven individuals, and place a high value on active participation instead of a monetary donation. When comparing the demographics of both, the main urban residents and monarch enthusiasts' samples, the latter tended to be from a higher income level, which could also help explain why citizen scientists are less motivated in their monetary preferences. This result is an example of income effect, a change in demand of a good or service in relation to a modification of an individual's income (Horowitz and McConnell, 2003), which has proven to be more than just an artifact from the valuation method (Roy et al., 1990), and can have important implications for designing a public engagement strategy (Hardy, 2013). For example, if high-income areas are almost self-driven toward ecologically-related activities, a certain proportion of economic resources invested could be diverted into low-income areas without losing too much participation. At the same time, this could provide broader support for conservation policies from other demographics more sensitive to financial incentives, e.g., low-income strata, farmers, other countries, and demographics that would be more sensitive to modifying their preferences with financial incentives such as participation rebates.

Value of Knowledge

Participatory approaches for conservation have increased over the last few decades (Fritsch and Newig, 2012), not only as a data-gathering tool but to acknowledge the importance that communities have within the conservation dialogue (Roberts and Jones, 2013). All else being equal, a program that engages and informs the community will have higher chances of success than a program that does not follow this path (Andrade and Rhodes, 2012). Here, we explored two vital elements of the most basic level of community knowledge: sharing a forecast of a program's success, and level of concern about the current situation of the monarch.

Community-based conservation is a viable method for bridging sociopolitical barriers for transboundary conservation (Berkes, 2007) but can have considerable struggle in achieving the involvement of the community. In particular, behavioral engagement (Sutton and Tobin, 2011) can be constrained by a lack of knowledge, in addition to other factors such as other competing priorities, and a lack of enabling initiatives (Lorenzoni et al., 2007). Here, we tested the effect of knowing the success of a program on the willingness to support monarch recovery. Firstly, we did not find any evidence of overshadowing (Huber, 1997) due to the high similarities among the estimates for most of the attributes between the two resident samples, particularly the sign of the estimates, and the relatively low RI estimates of this attribute from the main urban resident's sample.

The differences that did arise are, arguably, explained by factors unrelated to overshadowing. Overall, we detected that the sample without knowledge about the probability of success of the program showed a smaller willingness to support conservation measures in comparison to the one that was informed about the level of success. By telling the respondent about the expected success of the conservation program, a considerable objective constraint was presumably abated, motivating the increased support for the conservation program. Although we are cautious about the impacts of this finding given the difficulty in providing a reliable expected success estimate for conservation actions, we recommend that institutions should strive to synthesize available knowledge in a systematic, rational, and transparent way (Addison et al., 2013). Moreover, they must acknowledge the inherent uncertainties in their work to provide the relevant information necessary to aid the decision-making process (Peterson et al., 2003).

Furthermore, our research demonstrated, in support of findings from Best (2010), that the respondent's level of concern about the current status of the monarch strongly influenced the respondent's level of support for conservation actions. When respondents were aware of the current situation of the monarch and were concerned about it, they showed an increase in their willingness to support monarch conservation. Taken together, these utility shifts in relation to the amount of information provided is termed "information as a commodity" (Bucy, 2002), meaning people tend to place a significant value on being informed about the expected success of their decision making (Herian et al., 2012), even if that information has a certain level of uncertainty given by a percentage probability of success. This finding underscores the need for organizations to increase the information they provide to the public. Indeed, the ecological and population models of the monarch developed by several research teams (Yakubu et al., 2004; Batalden, 2011; Flockhart et al., 2015; Oberhauser et al., 2017) are not only a tool for better decision-making (Schmolke et al., 2010), but can be used as a tool for community engagement, if properly broadcasted by the institution leading the program. Lockwood (2010) proposes transparency and accountability of a management program as keystone elements for the effective governance of protected areas, and arguably, we can generalize those results into broader conservation objectives not confined within the borders of a protected area such as is the case of the monarch. This reliance on transparency for improving the support of a conservation program was evident in our results as well. Moreover, we were able to demonstrate that if the community perceives an information deficiency about the expected success of the program, they are more likely to endorse the use of resources for funding that research. Further studies should focus on linking this kind of behavior with management, policy development, and public engagement implications.

Willingness to Pay

The WTP of a hypothetical conservation program is calculated by summing the utility derived from the levels that comprise

the program's configuration and dividing it by the utility of the contribution attribute. Here, the WTP of the whole sample, estimated with the MNL, ranged between $100.41 and $141.01. Previously, Diffendorfer et al. (2013) estimated through a contingent valuation method a WTP per respondent ranging from $53.89 to $74.04. The difference between that study and our findings can be explained by a number of reasons. First, that study surveyed all U.S households whereas our study focused only in urban residents. Previous ecological studies have also found that respondents from rural areas have a lower WTP when compared to urban residents (Bandara and Tisdell, 2003). However, this should not be considered as indicative of a lower ecological interest from rural residents, rather it can be an evidence of an income effect (Train, 2009). Also, it is important to consider that the survey from Diffendorfer et al. (2013) was released in 2012, a time when most lay people were not aware about the role that milkweed had as a main driver of the monarch's plight.

CONCLUSION

The results of this research provide significant findings for understanding not only the social system surrounding the monarch butterfly, but also the general trends in preferences for transboundary conservation. Policy-makers and program managers need to understand the motivations of urban residents for supporting conservation strategies, acknowledging them not only as resource users but as a dynamic part of the system that acts and reacts to the rest of the system's elements (Berkes, 2004). As a response to that need, the most significant conclusion of this research is that the bulk of society places a higher value on international programs led by NGOs for the conservation of the monarch, even though the allocation of resources would be split amongst the participant countries instead of staying in their own country.

Without diminishing the importance of local programs, an international coordination body can play a pivotal role in the monarch conservation. The CEC, the environmental branch of the North American Free Trade Agreement (NAFTA), facilitates collaboration and public participation to foster conservation, protection and enhancement of the monarch and several other North American migratory species. We recommend to continue with the coordination efforts of the CEC's "Science for Monarch Butterfly and Pollinator Conservation" project and to include a new objective into that program aimed to strengthen outreach campaigns for urban residents across the three countries. However, recent political unrest across North America, particularly the dissolving the NAFTA (Stevenson, 2018), calls for alternative institutions that could be a surrogate or partner for the CEC.

The need for alternative non-governmental institutions to support the CEC on its coordination responsibilities brings us to the next key finding of this research. We observed that all else equal, most respondents prefer an international non-governmental organization to lead the monarch's conservation efforts. Currently, several organizations could serve this role. In the US, the Monarch Joint Venture has brought together a substantial number of institutions (government and non-government) proving to be an essential agent of change for US conservation policies (Oberhauser et al., 2015). However, the mandate of this coordinating body[10] bounds it to US-based institutions only and, unless a new mandate is created, it keeps it from scaling up to an international stage. An organization already participating at a worldwide-scale and playing a central role in conservation is the World Wildlife Fund which has been involved with the monarch butterfly almost since the discovery of the overwintering sites in Mexico (Brower and Missrie, 1999). Notwithstanding the vast contributions this institution has given to the conservation of the monarch, there are areas of opportunity that could increase its effectiveness, such as a higher involvement of the US and Canadian WWF offices. We, therefore, recommend improving the communication of these units, the same with other NGOs, and the coordination with other organizations alike.

Lastly, the strength of this study relies on its ability to be integrated with a population-ecology model of the monarch to create a coupled social-ecological system (CSES) model to increase the realism and applicability of the results. Within the context of natural resource management, previous empirical research has demonstrated the applicability and advantages of a CSES approach by incorporating societal responses as another dynamic element of the ecological system, e.g., Semeniuk et al. (2010) and Bodin et al. (2016), and is increasingly being evaluated as a useful transdisciplinary tool (Holzer et al., 2018). In the case of the monarch, such a coupled socio-ecological model can be used as a scenario forecasting tool for the design of conservation strategies (Peterson et al., 2003). By capitalizing on the support of urban residents for conservation initiatives, and additionally accounting for active participation of urban residents, citizen scientists, and other key stakeholders to increase habitat production, one could model the consequent impacts on monarch population and trends. That information and knowledge could then be used to feedback into a change of resident-level support dynamically; this is the focus of ongoing research.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of Tri Council Policy Statement: Ethical Conduct of Research Involving Humans (TCPS 2) and the Simon Fraser University Ethics Research Board's Policy R20.01; with written informed consent from all subjects. All subjects gave

[10]The Monarch Joint Venture Website (https://monarchjointventure.org/about-us; accessed on August, 2019) states that *"Our mission is to protect monarchs and their migration by collaborating with partners to deliver habitat conservation, education, and science across the United States."*

written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the Simon Fraser University's Research Ethics Board.

AUTHOR CONTRIBUTIONS

RS-S, CS, and WH conceived the presented idea. RS-S, KD, CS, and SF-L designed the surveying tool. RS-S and KD generated the experimental design. RS-S analyzed the data and developed the models, with contributions from SF-L. Manuscript written by RS-S, revised by CS with contributions of SC.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fevo.2019.00316/full#supplementary-material

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